USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

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Title: Collaborative Research on In Situ Denitrification and Glyphosate Transformation in Ground Water: NAWQA Eastern Iowa Basins Study Unit

Project Type: Research

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Keywords: Nitrate, Denitrification, Glyphosate, Transformation, Ground Water, In Situ Study

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Abstract: Contamination of ground water by nitrate and pesticides is widespread in some areas of the country and can threaten drinking water supplies. It is well known that the most important removal mechanism of nitrate and most pesticides from ground water is biodegradation, but the in situ transformation rates are largely unknown. In this study, two 180-L stainless steel chambers forming in situ mesocosms (ISMs) of aquifer sediments will be installed below the water table at the NAWQA agricultural chemicals study sites in the glaciated part of Iowa. This work will extend the use of this technique to examine denitrification in an area characterized by high dissolved iron concentrations and to measure the transformation rate of the extensively-used herbicide, glyphosate. The objectives for the research are:

1. Measure the denitrification and glyphosate transformation rates in the two ISMs.
2. Determine whether the denitrification is better fit by zero-order or first-order reaction rates.

3. Determine what donors are contributing electrons for the denitrification and their relative amounts.
4. Incorporate the results of the two ISMs into the existing databank of nine other ISM sites in glacial outwash aquifers in the Upper Midwest.
5. Update the available data of the apparent isotopic enrichment factor for 15N in nitrate versus denitrification rate among of ISM sites.
6. Update the nitrate vulnerability index and extrapolate the findings to similar, unmonitored agricultural and environmental settings.

Aquifer sediment samples will be collected from the Iowa site and analyzed for grain-size distributions, mineralogy, and major e- donors (organic carbon, sulfide, and ferrous iron) to determine optimum locations for installation of the ISMs, provide insights on the types and heterogeneity of e- donors at the site, and provide the e- donor supply data at the Iowa site that can be compared to previous ISM studies in the Upper Midwest. After the ISM chambers are installed, they will be purged and then amended with nitrate and bromide, which serves as a tracer for nitrate. Any loss of nitrate beyond that explained by dilution of the bromide tracer is attributed to denitrification. The ISMs will be sampled over time (months) and the decreases in nitrate concentrations will be used to calculate rates of denitrification. Modeling of the evolution of the geochemistry in the ISMs will provide insights into what donors contributed electrons to the denitrification and their relative amounts. The field experiment will be repeated a second time; however, in addition to nitrate and bromide, glyphosate will be added. Denitrification information from the second test will provide insights into the variability of the results from the first test. More importantly, the attenuation and transformation of glyphosate (with the dominate metabolite, AMPA) will be studied in both the presence and absence of nitrate to determine the fate of glyphosate in oxidizing and reducing conditions. The results of this study will provide site-specific transformation rates for nitrate and glyphosate and extend the aquifer nitrate vulnerability index that was developed in earlier studies. This information is vital for the development of tools and quantitative methods to characterize the transport and fate of agricultural chemicals in the Eastern Iowa Basins Study Unit, the Upper Midwest, and beyond.
